PATENT ABSTRACTS OF JAPAN

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(71)Applicant : HITACHI LTD

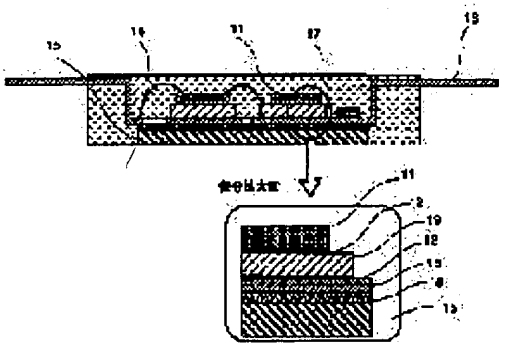
(72)Inventor : OGAWA TOSHIO
TAKAHASHI MASAAKI
AIDA MASAHIRO
KAMIMURA NORITAKA
YAMADA KAZUJI
SUZUKI KAZUHIRO
ENDO TSUNEHIRO
SHIGEMURA TATSUYA
NAKATSU KINYA

(54) SEMICONDUCTOR DEVICE

(57)Abstract:

PROBLEM TO BE SOLVED: To relax the stress concn. on an insulation layer, when the temp. changes by providing a heat sink held between electric insulation layers on the lead frame bottom face and forming a resin mold integrated with them, to form a uniform stable thickness insulation layer.

SOLUTION: A high thermal conductivity type heat diffusion board 19, e.g. is fixed to a power semiconductor element 11 via 9 solder 12, etc. The element 11 is fixed to a Cu lead frame 13 through a second solder layer 12. The lead frame 13 has been previously fixed to a Cu heat sink 15 by a resin insulation layer 18. The semiconductor element 11 is electrically connected to a wiring layer by bonding wires 16, and the entire system is formed by an armor resin mold 17 in a single body. Thus it is possible to



disposes a homogeneous and flat insulating layer on a metal plate surface and relax the stress concn. on the insulation layer 18, when the temp. changes since the entire circuit is covered with the single-mold resin layer.

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DETAILED DESCRIPTION

[Detailed description]
[0001]
[The technical field to which invention belongs] this invention relates to the hybrid integrated circuit system power semiconductor device which raised the heat-leakage nature from a semiconductor by taking the structure which the chip containing a semiconductor device was carried on the leadframe, and ****ed the electric-insulation layer about the semiconductor device which has the structure where the whole system was protected by the sheathing mould at the rear face of the leadframe section which fixes especially the semiconductor device of generation-of-heat nature, and has arranged the heat sink, and the rear face of this heat sink exposed outside. Therefore, the semiconductor device by this invention can carry out a deployment to the inverters for output controls, such as wide use and an industrial device, etc.
[0002]
[Prior art] There are the following three configurations as this conventional kind of a power semiconductor device. One is open patent official report common [5-226575]. It is indicated by the number. This carries a power semiconductor device directly on a heat sink or a leadframe, and really carries out the resin molding of the sheathing. In the semiconductor device which has this structure, a power semiconductor device can be directly fixed in a heat sink, and thermal resistance is low, and since there are few parts mark, it is effective in high-reliability-izing. However, it has the following fault. Since an insulating layer is not minded between a power semiconductor device and a heat sink, an application of the un-insulating type power semiconductor device ****ed also at a collectors side, such as IGBT (Insurated Gate Bipolar Transistor), is difficult. Although the proposal which arranges an insulating layer to a heat sink front face or the interior is also shown, difficulty is in loading of two or more power semiconductor devices which operate individually in this case, for example, complicated circuits formation, such as a main circuit of an inverter, is difficult.
[0003] Other one is indicated by the open patent official report common of No. 63822 [three to], and the open patent official report common of No. 80748 [six to]. That is, the opening between predetermined spacings is beforehand prepared on a metaled heat sink, a power semiconductor device is set, a resin is slushed for the whole sheathing section containing this opening as a mould of one, and a semiconductor device is constituted. Since a resin layer intervenes between the conductor layers and heat sinks which fixed the semiconductor device according to this structure, a high reliability is acquired from two or more loading of the aforementioned un-insulating type power semiconductor device being easily possible, and there being few parts mark. However, as mentioned above, it is the technique of slushing a resin into the space which set the element beforehand, and while there is fear of the contamination of a void at the time of molding, a resin layer thickness tends to become unstable. Usually, the thermal conductivity of this seed resin layer is very low, and it is difficult for it for the error of some thickness to serve as big dispersion as thermal resistance, and to obtain the stable quality in the mass-production works. Since it is the same, it is difficult to make the thickness of an insulating layer sharply thin (for example, 0.1mm or less), and to also lower thermal resistance from the field of a resin

moldability. Other one is indicated by the open patent official report of No. 2282 [Showa 52 to], and the open patent official report of No. 207645 [Showa 59 to]. That is, an insulating resin layer is prepared between a leadframe and a heat sink, and the resin mould of one is formed. Since the heat which occurred by the semiconductor device radiates heat through a direct insulating layer according to this configuration, there is a fault that thermal resistance will become high. How to thicken thickness of the lead directly under a semiconductor locally, and diffuse heat horizontally as a policy which avoids this, is also considered. However, according to this technique, the variant leadframe from which thickness is different is required, and a manufacturing process becomes complicated and it is not desirable in respect of a reliability and price.

[0004]

[Object of the Invention] this invention solves each trouble of the above-mentioned conventional method, it is low-fever resistance and high-reliability and a small power semiconductor device are realized. That is, between a leadframe and the layer of a heat sink, by applying the specific electric-insulation layer other than a sheathing mould material, the insulating layer which has the thickness which was homogeneous in the lower part of a power semiconductor device, and was stabilized in it can be formed, the stress concentration to the insulating layer at the time of the temperature change mentioned above is eased, and high-reliability and a small power semiconductor device are offered as a result.

[0005] Other purposes of this invention offer easily the structure required of a practical power semiconductor device of having the low thermal resistance which was suitable for the heat leakage and was stabilized, by the low cost.

[0006]

[The means for solving a technical problem] In order to attain the above-mentioned purpose, the following means are taken in this invention.

[0007] 1. In Semiconductor Device Which Has Structure Which Generation-of-Heat Nature Semiconductor Device Fixes on Conductor Circuit, and was Protected by Electric-Insulation Sheathing Mould It is the type which this semiconductor device fixes on a leadframe, this leadframe ****s an electric-insulation layer, and a heat sink is arranged, and a part of this heat sink rear face [at least] exposed outside substantially. It is constituted by the circuit sheathing mould of these series in one, and considers as the semiconductor device with which this mould consists of a single resin layer substantially.

[0008] 2. Consider as the semiconductor device which consisted of this semiconductor device by forming the thermal diffusion plate with a big flat-surface configuration between the layers of the aforementioned semiconductor device and the aforementioned electric-insulation layer in the above 1.

[0009] 3. In the above 1 or the above 2, the aforementioned electric-insulation layer considers as the semiconductor device constituted by the resin system material.

[0010] 4. In the above 3, the aforementioned electric-insulation layer and the aforementioned mould resin layer use at least one of an epoxy system resin, a cyanate system resin, a silicone system resin, a phenol system resin, a polyimide system resin, and polyamide system resins as the semiconductor device with which it was constituted as a principal component, and the aforementioned thermal diffusion plate was constituted by copper or aluminum.

5. Consider as the semiconductor device with which 50 percent by volumes and the maximum were also constituted at least in the aforementioned electric-insulation layer including the inorganic system filler of 90 percent by volumes in the above 4. furthermore, the chip for control-system circuits which drives the aforementioned semiconductor device on the aforementioned conductor circuit in the 6. above 1 or the above 5 -- and -- or it considers as the semiconductor device constituted including the chip for protection system circuits which supervises an overcurrent, the degree of hyperthermia, etc.

[0011] 7. the chip for control-system circuits which drives the aforementioned semiconductor device in the above 6 -- and -- or let the chip for protection system circuits which supervises an overcurrent, the degree of hyperthermia, etc. be the semiconductor device constituted by arranging on the printed wired board

[0012] 8. In the above 7, a part of aforementioned semiconductor device front face considers as the structure protected by the ****** resin coat at least.
[0013] 9. In the above 8, the top side of this resin mould, with the aforementioned heat sink, the derivation section of the aforementioned terminal derived to the exterior of the aforementioned resin mould is arranged in the field of an opposite side, and considers as the structure of the plane of projection from above [of this mould] arranged inside at least.
[0014] The operation by the configurations 1-9 of the above-mentioned this invention is as follows. The following numbers are equivalent to the number of a configuration.
[0015] 1. -- the active element which fixed on the leadframe -- and -- or with a passive element In the power semiconductor device of the structure where have a terminal for I/O with the conductor circuit and the exterior which connect it electrically, and these circuits system was protected by the resin system mould Since an electric-insulation layer is ****ed, a heat sink is arranged, and this resin system mould is constituted in one by this leadframe inferior surface of tongue and this mould is substantially constituted with a single resin ********** hard resin The design degree of freedom when being able to arrange a homogeneous and flat insulating layer on a metal-plate front face, being able to fix the un-insulating type power semiconductor device with the collector electrode in a direct heat sink through a conductor layer at the pars basilaris ossis occipitalis, and arranging a conductor wiring is high, and is effective in high-density-izing or the miniaturization. Furthermore, since the whole circuit containing a power semiconductor device is covered by the single mould resin layer, this insulating layer is reinforced and the stress concentration to an insulating layer can be eased. Usually, in addition to sufficient electric insulation, there is good thermal conductivity as a material property required of this seed insulating layer. In order to realize this, generally with the resin system material, a lot of fillers are contained inside. Therefore, with stress, it can be called the configuration which is easy to generate a crack, and there is an operation which reinforces this insulating layer by the sheathing mould.
[0016] On the other hand, about the resin for moulds, there is no need of considering the thermal conductivity of a material specially, and it is high. [of the degree of freedom of a material selection] Therefore, the material which has the intensity and coefficient of linear expansion of stress-proof nature can be selected. Occurrence of the crack of the insulating layer resulting from the difference of the coefficient of linear expansion with the silicon which constitutes a semiconductor device from reinforcing an insulating layer by this mould material etc. can be suppressed.
[0017] 2. In the above 1, apart from the aforementioned leadframe, since a thermal diffusion plate is formed between the layers of the side near the aforementioned semiconductor device rather than the aforementioned electric-insulation layer, acquire the property by which thermal resistance was stabilized low. After this thermal diffusion plate diffuses horizontally the heat which occurred by the semiconductor device and extends a heating surface, it has the operation which generally carries out a heat leakage to a heat sink through a thermally conductive low electric-insulation layer. Low-fever resistance is realized as the result.
[0018] 3. In the above 1 or the above 2, since a resin system material constitutes the aforementioned insulating layer, a manufacturing process is simplified and the cost of materials can also be suppressed. Therefore, a productivity is good and is advantageous to low-cost-izing.
[0019] 4. In the above 3, since the aforementioned resin system material is constituted as a principal component in at least one of an epoxy system resin, a phenol system resin, a polyimide system resin, and polyamide system resins, while sufficient electric insulation of a between [a leadframe and a heat sink] is obtained, both firm adhesion is possible. Furthermore, since the aforementioned thermal diffusion plate is constituted by copper or aluminum, the internal stress at the time of a temperature change can be suppressed, and there is an operation which prevents the crack of an insulating layer. In the conventional power module structure, the material with low (below 6 ppm / K) coefficient of linear expansion, such as AlN or Mo, is used for the lower part of a power element as a thermal diffusion plate in order to usually ease thermal stress. However, this invention persons found out the following thing from the experiment and the stress-analysis result. If a resin one apparatus mould is applied to the conventional module structure, stress will concentrate on a resin insulating layer and it will become the structure

which a crack tends [very] to generate. That is, if coefficient of linear expansion of a thermal diffusion plate, a resin layer, and a power element is set to alpham, alphar, and alphas, respectively, it will be set to alphar>>alpham>alphas and stress will concentrate on a resin insulating layer. Here, the examples of a value (ppm/K) with each typical near coefficient of linear expansion are alphar(15) alpham (5.9) and alphas (3.5). Consequently, a crack is generated in a resin insulating layer and a maintenance of very important isolation voltage is difficult on the property of a power module. If the resin material by this invention and thermal diffusion plate which were mentioned above are applied, the configuration of the above-mentioned coefficient of linear expansion can be set to alpham>alphar>alphas. Consequently, the stress concentration to a resin insulating layer can be eased sharply, and a reliable power module can be offered. Here, the examples of a value (ppm/K) with each typical near coefficient of linear expansion are alpham (17-23.5), alphar (10-15), and alphas (3.5).

[0020] 5. In the above 4, since the filler of 50 percent by volumes is included in the layer of the aforementioned electric-insulation layer at least, there is an operation which keeps low the thermal resistance of a between [a leadframe and a heat sink].

[0021] 6. In the above 1 or the above 5, the become [independent] type semiconductor device which can correspond quickly and pertinently at the time of abnormalities, such as an overcurrent and the degree of hyperthermia, can be constituted by combining and arranging protection system passive circuit elements in addition to a power semiconductor device.

[0022] 7. the chip for control-system circuits which drives the aforementioned semiconductor device in the above 6 -- and -- or since the chip for protection system circuits which supervises an overcurrent, the degree of hyperthermia, etc. is arranged on a printed wired board, the detailed wiring is possible

[0023] 8. In the above 7, since a part of aforementioned semiconductor device front face considers as the structure protected by the ****** resin coat at least, while permeation of the moisture from the exterior is prevented, there is an operation which eases the internal stress of the semiconductor device located in a resin mould.

[0024] 9. since the derivation section of the aforementioned terminal derived to the exterior of the aforementioned resin mould is arranged with the aforementioned heat sink in the field of an opposite side and considers as the structure of the plane of projection from above [of this mould] arranged inside at least the top side of this resin mould in the above 8 -- space distance , such as a cooling fin , -- and -- or **** distance can be secured sufficiently for a long time , and there is operation of acquire , high insulation , i.e. , high-reliability

[0025]

[Gestalt of implementation of invention] Hereafter, although an example explains this invention still in detail, this invention is not limited to these.

[0026] The configuration cross section by one example of this invention is shown in example 1 drawing 1 . For example, the power semiconductor devices 11, such as IGBT (InsulatedGate Bipolar Transistor) which fixed the thermal diffusion plate 19 of high temperature conductivity constituted from copper by the means of solder 12 etc., fix on the copper leadframe 13 through the 2nd solder layer 12 further. This leadframe 13 uses beforehand what fixed in the copper heat sink 15 by the resin insulating layer 18. the coefficient of linear expansion of these copper -- about 17 ppm / K it is . The power semiconductor devices 11 are the coefficient of linear expansion of about 3.5 ppm / K, and are the structure where it was electrically joined to the wiring layer by the bonding wire 16 of aluminum, and the whole system was really cast by the sheathing resin mould 17. The power semiconductor device of this structure which set coefficient of linear expansion of the resin insulating layer 18 and the sheathing resin mould 17 to about 15 ppm / K is created by the following process. First, the IGBT element 42 as a 7mmx7mm semiconductor device 11 is joined by solder to the predetermined position on the 10mm 10mmx thermal diffusion plate 19. 0.15mm in thickness which made the glass cloth impregnate an epoxy system resin between leadframe 13 inferior surface of tongue and heat sink 15 top on the other hand On both sides of a resin adhesion sheet, it is stuck by pressure, both are fixed, and the resin insulating layer 18 is formed. 180 degrees C of 50kg /of this sticking-by-pressure condition were set as for 2 and 1 minute cm. By the bonding wire 16, the element 11 and the leadframe 13 containing this thermal diffusion plate 19 are

joined electrically.
[0027] a series of circuit prepared at the above-mentioned process -- metal mold -- it sets to inside, the resin mould 17 is fabricated by the radiation method at predetermined temperature, for example, 180 degrees C, and the power semiconductor device by this invention is obtained In this example, Table 1 was used as this charge of mould 17 material.
[0028]
[Table 1]

表 1

材　　料	配合比
Ｏークレゾールノボラック型エポキシ樹脂	９０
ブロム化フェノールノボラック型エポキシ樹脂	１０
フェノールノボラック樹脂	５２
トリフェニルホスフィン	1
三酸化アンチモン	4
エポキシシラン	2
ヘキストワックス	1
カーボンブラック	1
エポキシ変性ポリジメチルシロキサン	１０
酸化けい素（球状粉末）	６４３

[0029] The blending ratio of coal of Table 1 shows a weight ratio. For this material, since many oxidization silicon is included as a filler, Young's modulus is 2 1800 kgves/mm. Rigidity required [it is high, and] in order to protect the interior is provided. Moreover, coefficient of linear expansion is 15 ppm/degree C. Since it is low, the curvature of the heat sink 15 after molding and hardening is as small as about 40 micrometers, and is in the level which is satisfactory practically. With the thermal diffusion plate 19, since the structure by this example is structure which radiates heat to a heat sink side through the resin insulating layer 18 after extending heat horizontally, a heating surface becomes large and it can reduce thermal resistance. For example, a public notice patent official report common 3-63822 As compared with the conventional technique indicated by the number, the very low thermal resistance below a half is obtained. For this reason, generally the application for the element 11 of high current capacity with much calorific value is possible for the semiconductor device by this invention. On the other hand, since it is the heat transfer which lets a resin insulating layer pass, it is restricted to some extent to the capacity of until practical. That is, the module of the structure by this invention is usually suitable for the application in the calorific value 1 or the domain of 50W/element. The withstand voltage with a grand layer is at least 2.5kV. It is realizable.
[0030] In this example, as a semiconductor device 11, although the example of the IGBT element 42 was shown, MOS system transistors etc. may be other generation-of-heat nature elements, for example.
[0031] Moreover, in this example, as a filler contained in the resin mould 17, although the oxidization silicon of Table 1 was shown, you may be other materials, for example, a beryllia, **********, a silicon nitride, an aluminium nitride, a silicon carbide, etc. Moreover, although this example showed the example which uses an epoxy system resin as a resin material of the resin insulating layer 18, this has the technique of being other resin system materials, for example, sandwiching adhesion sheets, such as acrylic or a polyimide system, between a leadframe 13 and the heat sink 15, and carrying out thermocompression bonding, or the technique of screen-stenciling. Moreover, although the example of a glass fiber was shown as aggregate of a resin insulating layer, other material powder, such as a beryllia, **********, a silicon nitride, an aluminium nitride, a boron nitride, a diamond, an alumina, and glass, is applicable as the aggregate, i.e., a filler, for example. In this case, screen-stencil is suitable as the technique of carrying out the optimum-dose variance of the filler in the resin.
[0032] As other modifications of this example, the example which took out the lead terminal 21 upward

is shown in drawing 2 . That is, since the space distance or **** distance with the terminal 13 and the cooling fin 35 which carried out derivation section arrangement can secure structural sufficiently for a long time inside a mould resin on the projection drawing from a top, the high insulation between both is acquired.

[0033] You may be the following technique although this example showed the example which joins beforehand a semiconductor device 11 and the thermal diffusion plate 19 by solder, and uses them. namely, the top of a leadframe 13 where a semiconductor device 11 is arranged -- and -- or a predetermined position at the bottom -- the thermal diffusion plate 19 -- for example, the soldered thing is prepared beforehand Subsequently, the heat sink 15 or the semiconductor device 11 is joined to this leadframe 13.

[0034] The cross-section block diagram of the semiconductor device by other examples of example 2 this invention is shown in drawing 3 . By the same technique as an example 1, the power module as three-phase-circuit AC power supply is constituted. A total of the fraction from which the IGBT element 42 and the Lee wheel diode element 43 became [the fraction which laid six diode elements for a rectification 41] the pair about the converter section 45, and 12 elements constitutes the inverter section 46, respectively. The gate for G driving the IGBT element 42 in the terminal in drawing and E express the lead terminal of an emitter, respectively. Similarly, the output terminal for R, S, and T driving three-phase-circuit AC power supply, and U, V, and W driving a motor etc., and P and N show the direct-current terminal connected to a smoothing capacitor, respectively. Except that the number and modality of element increase, the manufacturing process of this module is the same as that of an example 1 almost, and omits a description here.

[0035] The cross-section block diagram of the semiconductor device by other examples of example 3 this invention is shown in drawing 4 . By the same technique as an example 1, a power system circuit is constituted two or more power semiconductor devices 11 in the predetermined position on a leadframe 13. Subsequently, a polyamide system resin (for example, tradename highness mull-Hitachi Chemical make) is applied to the front face of a bonding wire 16 which connects this element 11 and this to the conductor wiring section. Mean paint film thickness is about 0.1mm. It carried out. If too thick [if this thickness is thin, sufficient effect will not be acquired, but], the mismatch of the cubical expansion by the linear-expansion difference is not greatly desirable. For this reason, as for a paint film, it is desirable to usually be adjusted to the domain of 5 micrometers - 300 micrometers.

[0036] The cross-section block diagram of the semiconductor device by other examples of example 4 this invention is shown in drawing 5 . By the same technique as an example 1, a power system circuit is constituted two or more power semiconductor devices 11 in the predetermined position on a leadframe 13. Subsequently, through the control circuit system containing IC for a gate drive31 which drives this element 11, and the printed wired board 36 which consists protection system circuits, such as an overcurrent protection, of a glass-epoxy system resin substrate, resin system adhesives are used for the predetermined position on a leadframe 13, and it fixes. This printed wired board 13 is connected directly electrically in the leadframe 13 or a power system circuit by the bonding wire 16. a series of circuit prepared at the above-mentioned process -- metal mold -- it sets to inside, the resin mould 17 is fabricated at predetermined temperature by the radiation method, and the power semiconductor device by this example is obtained

[0037] The inverter was made as an experiment on the basis of the power semiconductor device by this invention of the example 1 shown in example 5 drawing 1 . The cross-section block diagram is shown in drawing 6 , and a circuit block diagram is shown in drawing 7 , respectively. IC for a gate drive31, the smoothing capacitor 32, the diode bridge for rectifier circuits 33, etc. are added other than the configuration of drawing 1 , and a control oriented microcomputer, a power circuit, etc. add 34, and constitute an inverter module from this example.

[0038] This trial production inverter was connected to the three phase induction motor, and it operated, and checked acquiring a good property. It turns out that the reliability by the repeat use accompanied by a temperature change is high.

[0039]

[Effect of the invention] As explained above, according to this invention, there is the following effect.
[0040] 1. On a leadframe 13, a semiconductor device 11 is fixed, a heat sink 15 is arranged through an electric-insulation layer, and since it has the structure of reinforcing the whole with the resin mould 17, low thermal resistance and the effect of realizing a high reliability simultaneously are.
[0041] 2. Since the aforementioned semiconductor device 11 fixes through the thermal diffusion plate 10 independently [a leadframe 13], there are formation of low-fever resistance and an effect of low-cost-being easy toize.
[0042] 3. Since the aforementioned electric-insulation layer is constituted by the resin material, a manufacturing process can be simplified and it is effective in realizing low-cost-ization.
[0043] 4. By using a specific material for the insulating layer, the mould resin, and thermal diffusion plate of the above 3, secure the electric insulation and adhesive property to need, ease the stress concentration of a resin insulating layer, and it is effective in realizing a high reliability.
[0044] 5. Since an inorganic system filler is included in the insulating layer of the above 4, stop the thermal resistance of this insulating layer low, and also it is effective in reducing coefficient of linear expansion.
[0045] 6. Since a protection system circuit is arranged near the main circuit containing a semiconductor device 11, the inverter of the structure which it can correspond more quickly and the optimum at the time of occurrence of an unusual situation, and the effect of realizing small and a high-density inverter module is in it, for example, was united with the motor at it is obtained.
[0046] 7. Since a printed wired board 36 is used, a high-density wiring is attained and it is effective in realizing miniaturization and high-reliability-ization.
[0047] 8. By forming the adhesive good flexible coat 37 in the element 11 circumference and the front face of a bonding wire 16, moisture resistance and stress-proof nature improve, and it is effective in realizing miniaturization and high-reliability-ization.
[0048] 9. By using the vegetation position of a lead terminal 21 as the top of an opposite side in a heat sink 15, the space distance with a gland can be taken enough, an insulating property improves, and it is effective in realizing high-reliability-ization.

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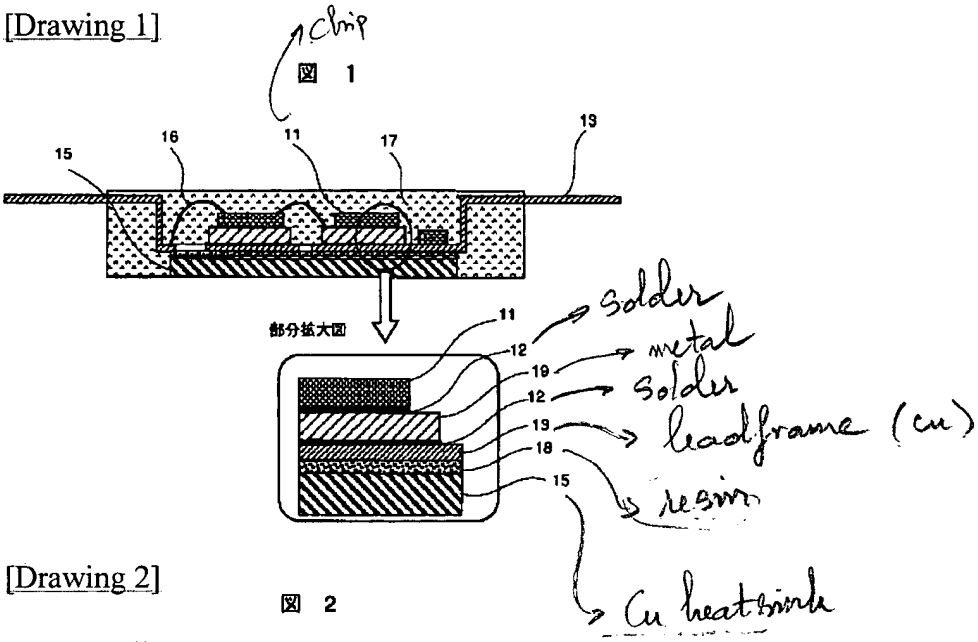
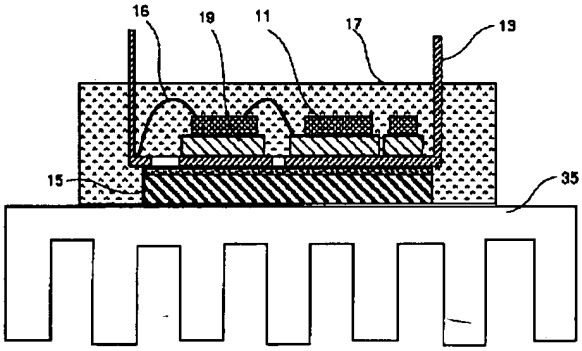
DRAWINGS

[Drawing 1]



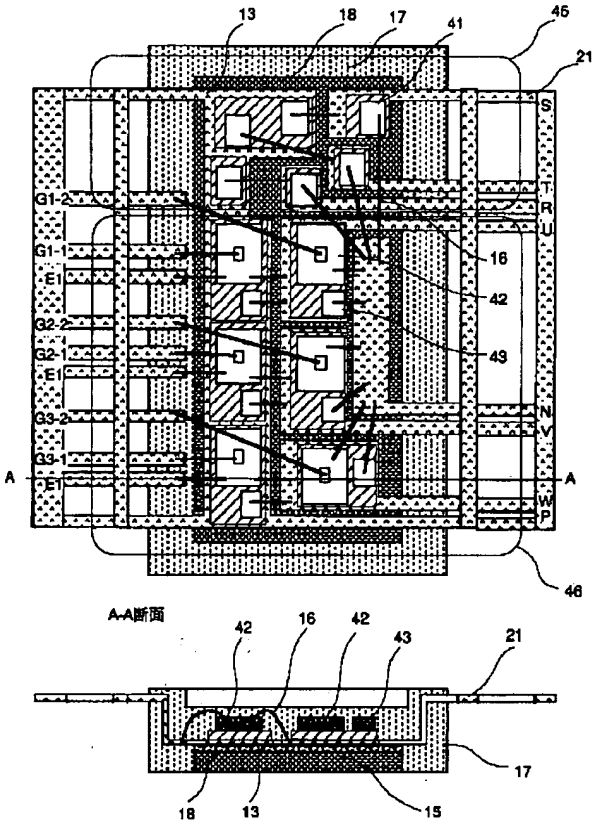
[Drawing 2]

図 2



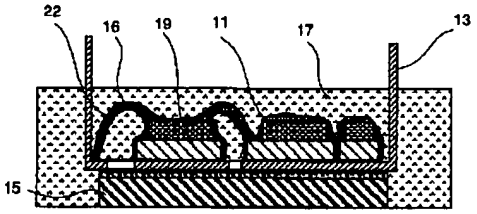
[Drawing 3]

図 3



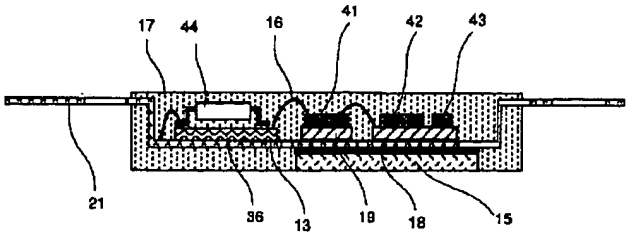
[Drawing 4]

図 4



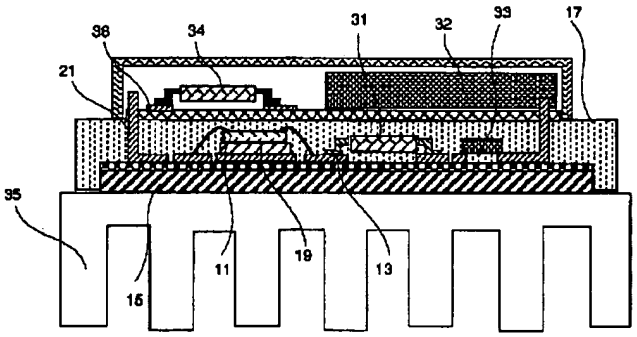
[Drawing 5]

図 5



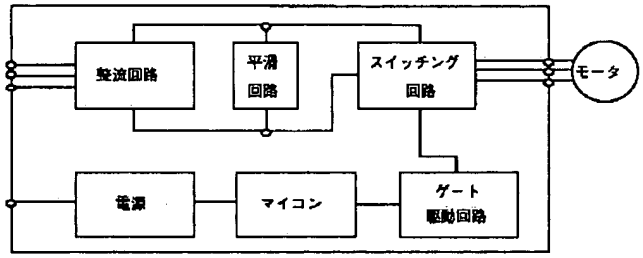
[Drawing 6]

図 6



[Drawing 7]

図 7



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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] The cross-section block diagram of the power semiconductor device by one example of this invention.
[Drawing 2] The cross-section block diagram of the power semiconductor device by other examples of this invention.
[Drawing 3] The cross-section block diagram of the power semiconductor device by other examples of this invention.
[Drawing 4] The cross-section block diagram of the power semiconductor device by other examples of this invention.
[Drawing 5] The cross-section block diagram of the power semiconductor device by other examples of this invention.
[Drawing 6] The cross-section block diagram of the inverter module by one example of this invention.
[Drawing 7] The circuit block diagram of the inverter module by one example of this invention.
[Description of Notations]
11 [-- A leadframe, 15 / -- Heat sink,] -- A semiconductor device, 12 -- Solder, 13 16 [-- Resin insulating layer,] -- A bonding wire, 17 -- A sheathing resin mould, 18 19 [-- IC for a gate drive 32 / -- Smoothing capacitor,] -- A thermal diffusion board, 21 -- A lead terminal, 31 33 -- The diode bridge for rectifier circuits, 34 -- A control oriented microcomputer, a power circuit, etc., 35 [-- A flexible coat, 41 / -- A rectifier-diode element, 42 / -- An IGBT element, 43 / -- The Lee wheel diode element, 45 / -- The converter section, 46 / -- Inverter section.] -- A cooling fin, 36 -- A printed wired board, 37

[Translation done.]